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THE MINERALOGY OF ASBESTOS DUST*

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THE term asbestos has no definite mineralogical significance, but is applied to several minerals which, under certain circumstances, occur in fibrous form. The hydrous magnesium silicate "chrysotile" (or serpentine asbestos) is the most widely used of these asbestos minerals. According to recent figures of the U. S. Bureau of Mines (1) over 90 per cent of the asbestos fabricated in the United States comes from mines near Thetford, Quebec. These mines are the leading producers of chrysotile. Other forms of asbestos are "Crocidolite," soda-iron silicate; "amosite" and "anthophyllite," iron-magnesium silicates, but all are of minor importance from a quantitative point of view.

Dusts generated in the processing of asbestos are known to be harmful when inhaled in sufficient quantities, and the mineralogical composition of such dusts is an important factor in the problem of the effects on the respiratory system. During the past year the writers secured for petrographic analysis dusts from six asbestos plants in various parts of the country. Samples of rafter dust created by many of the different operations in both spinning and molding of asbestos were obtained. Microscopic examination of the dusts revealed a most startling condition, namely that asbestos fibers in respirable sizes make up only a very small percentage of the various dusts.

The generally accepted maximum size for dust particles which can penetrate into the lungs is about 10 microns. As a result of animal experimentation with asbestos dust, however, Gardner and Cummings (2) state: "The experiments demonstrate that fibrous structures at least as long as 200 microns can pass the protective mechanism of the upper respiratory tract and enter the lungs." This is confirmed by human lung sections of asbestosis victims which the writers have seen. Thus the percentages given in the following tables represent the *number* of particles less than 10 microns in maximum dimension for all minerals except asbestos. In the case of that mineral, fibers as long as 200 microns are included as respirable providing their maximum thickness does not exceed 5 microns. In none of the dusts examined was there present more than a trace of asbestos with the maximum dimension less than 10 microns.

The mineral particles which make

* Received for publication October 7, 1935.

up the bulk of the respirable portions of these dusts are the impurities found in raw asbestos. Figure 1 shows the paucity of asbestos fibers in the dust and the relative abundance of granular material. As the composition of dusts from similar operations in all plants was analogous, only two groups of data are necessary to illustrate the existing conditions. Moreover, all of operation, but they were largely confined to the sizes above 200 microns. The amount of respirable material in this dust was smaller than in the other two, for most of it is apparently liberated in operations preceding the spinning.

Because cement is used in the manufacture of many molded asbestos products, calcite (calcium carbonate) is

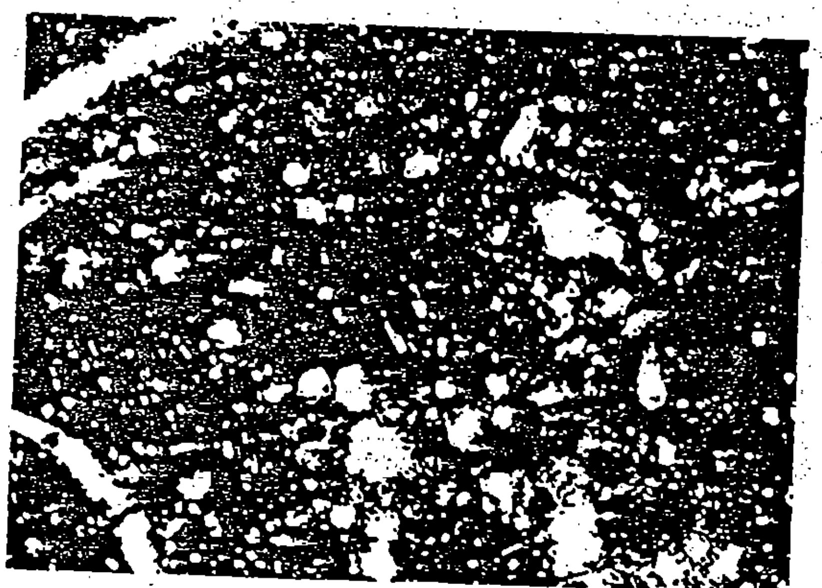

FIG. 1.—Photomicrograph of dust from preparation room. The black grains are magnetite, while the light ones are mostly carbonate and talc with some serpentine. A few fibers of asbestos can be seen. The large white fiber to the left of the picture is organic. (Crossed nicols 175 ×)

the plants included in the investigation use chrysotile as the raw material.

The dust produced by the preparation of the asbestos contained a higher percentage of respirable asbestos fibers than any of the other dusts examined. The carding dust consisted of some coarse (25 to 300 microns) asbestos fibers and abundant respirable grains of other minerals. Asbestos fibers dominated the dust from the spinning

generally the chief constituent of the dusts from such operations. Thus, all of the samples examined from this type of work contained a large percentage of acid soluble (1:10 HCl) material by weight. The lowest was 64.8 per cent.

Asbestos in long fibers is an important constituent of the dusts from the mixing and pulverizing operations but is relatively unimportant in re-

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spirable sizes. Dust from the cutting room showed almost no asbestos. The small percentage of respirable asbestos is even more impressive when it is considered that 90 per cent of the total *number* of particles of all the dusts were respirable.

In most of the samples asbestos is present in sizes varying from 20 to 500 microns in length and from ½ to 50 microns in diameter. Practically all particles, however, are over 100 microns in their longest dimension. The reason for the scarcity of asbestos in shorter fibers is no doubt due to its physical nature. Asbestos is bounded parallel to its elongation by perfect planes of cleavage which permit it to break into almost infinitely slender fibers while still retaining its original length. The processing, therefore, splits the asbestos finer and finer with little tendency to shorten it. Moreover, inasmuch as the fibers tend to mat together they are less likely to be picked up by air currents. Granular particles, such as the foreign material present in these dusts, are easily dispersed.

TABLE 1

Dust Produced in the Manufacture of Asbestos Textiles

	Preparation	Carding	Spinning
	per cent	*per cent*	*per cent*
Talc	6	9	5
Carbonate	30	27	21
Magnetite	28	21	27
Serpentine	14	29	27
Asbestos	15	8	8
Others	7	6	12

TABLE 2

Dust Produced in Molding Operations in the Manufacture of Asbestos Building Bricks, etc.

	Cutting room	Mixing room	Pulverizer
	per cent	*per cent*	*per cent*
Talc	4	trace	trace
Carbonate	75	70	70
Magnetite	trace	4	9
Serpentine	4	10	6
Asbestos	trace	3	trace
Others	17	13	15

The talc, serpentine, magnetitite, and carbonate so abundant in the dusts are all impurities in the asbestos as mined. Figure 2 shows the raw material with these minerals clinging to the long fibers of asbestos. In all cases where the Canadian raw material was examined microscopically, the mineral assemblage of impurities is essentially the same.

Talc is a mica-like hydrous magnesium silicate, and its platy character permits it to be dispersed easily and stay suspended in the atmosphere. Serpentine is chemically identical with asbestos (chrysotile); it is the material composing the rock in which asbestos veins are found. Unlike asbestos, however, it breaks into equidimensional grains that have no tendency to mat together. Magnetite is an iron oxide which also forms granular particles. Carbonate as listed in the analyses includes three carbonates—calcite ($CaCO_3$), dolomite [$(Ca,Mg)CO_3$], and magnesite ($MgCO_3$)—all having similar physical properties; and, like serpentine and magnetite, they break into roughly equidimensional particles. The physical nature, then, of all these impurities permits them to be liberated from the asbestos during processing operations and thus find their way into the plant atmosphere.

Gardner and Cummings of the Saranac Laboratory have for some time been carrying on experimental work in asbestosis (2). They subjected guinea pigs, white rats, and rabbits 8 hours a day, for as long as 2⅓ years, to air laden with asbestos dust. The material used for these experiments is called King's Floats, an asbestos dust obtained from the Thetford producers. A petrographic analysis of this material is given in Table 3.

The material in King's Floats larger than 10 microns in maximum dimension was found to be essentially the same as that below 10 microns, with the addition of asbestos, the fibers of which vary in length from 50 to 300 microns and average about 15 microns in diameter.

FIG. 2. Photomicrograph of raw asbestos used in spinning. A portion of a hair-like asbestos fiber is shown after it had been separated into many smaller fibers. Note the abundance of granular impurities that have been set free by crushing. (Crossed nicols 160 ×)

TABLE 3

Respirable Material in King's Floats

Serpentine	40%	Carbonate	18%
Magnetite	12%	Talc	12%
Asbestos	14%	Others	4%

Summary

Petrographic analyses of rafter dust from six asbestos processing plants, including molding and weaving of asbestos, disclosed that in the respirable sizes, asbestos is a relatively unimportant constituent. Talc, serpentine, carbonates and magnetite predominate in all of the dusts examined. The question arises as to the importance of the part played by these minerals in lung damage resulting from dust exposures in the asbestos industries.

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